Computer Science 384
St. George Campus

Wednesday, January 24, 2018
University of Toronto

Homework Assignment #1: Search
— Part II —
Due: Monday, February 5, 2018 by 11:59 PM

Silent Policy: *A silent policy will take effect 24 hours before this assignment is due, i.e., no question about this assignment will be answered, whether it is asked on the discussion board, via email or in person.*

Late Policy: 10% per day after the use of 3 grace days.

Overview: Assignment #1 is comprised of two parts. Part I is a programming assignment. Part II is a small set of short answer questions that accompany Part I. This document details Part II, the short answer questions.

Total Marks: Part II has a total of 20 marks. (Recall that Part I has a total of 50 marks.)
Assignment #1 (Part I and Part II) has a total of 70 marks that represent 10% of the course grade.

Handing in this Assignment

What to hand in on paper: Nothing.

What to hand in electronically: Create a file called `writtenAnswer.txt` and submit this along with the files you create for Part I using MarkUs. Your login to MarkUs is your teach.cs username and password. You can submit a new version of any file at any time, though the lateness penalty applies if you submit after the deadline. For the purposes of determining the lateness penalty, the submission time is considered to be the time of your latest submission. More detailed instructions for using MarkUs are available at: http://www.teach.cs.toronto.edu/~csc384h/winter/markus.html.

Clarification Page: Important corrections (hopefully few or none) and clarifications to the assignment will be posted on the Assignment 1 Clarification page:
http://www.teach.cs.toronto.edu/~csc384h/winter/Assignments/A1/a1_faq.html.
*** You are responsible for monitoring the A1 Clarification page.***

Help Sessions: There will be approximately three help sessions for this assignment. Dates and times for these sessions have been posted to the course website and to Piazza.

Questions: Questions about the assignment should be posed on Piazza:
https://piazza.com/utoronto.ca/winter2018/csc384.
If you have a question of a personal nature, please email the A1 TA, Andrew Perrault, at perrault at cs dot toronto dot edu or the instructor at csc384prof at cs dot toronto dot edu placing 384 and A1 in the subject line of your message.

Files you'll create and edit:

- writtenAnswer.txt: where the requested written responses should be placed.

Question 1 (20 points): Short Answer Questions

Write your answers to these questions in `writtenAnswer.txt`.

(1) Assume Pacman is in an NxN maze with no interior walls.

(1a) What is the branching factor of the successor function (i.e., the maximum number of states produced by the successor function) if Pacman is in the corner? Explain your answer. (1 point total)

(1b) What is the branching factor of the successor function if Pacman is in the middle? Explain your answer. (1 point total)

(1c) What is the maximum possible depth of the search space? Explain your answer. (1 point total)

(2) You've been asked to analyze space requirements for Pacman's OPEN list when using A* with a monotone heuristic and starting from a fixed location. Your game has been engineered such that transitions all have non-zero positive costs, c, such that $cmin \leq c \leq cmax$. Assume there is no cycle checking.

Let $ctotal$ represent the optimal cost solution and assume the maximum number of states produced by the successor function is 4. Each node in the search space is comprised of the current state as well as the path taken to get to that state. As such each node on the OPEN list corresponds to a different path that is being explored.

(2a) Define the maximum number of paths on the OPEN list, n, at the time the solution is found. Your answer should be in terms of the parameters defined above. Explain your answer. (4 points total)

(2b) Conversely, if you only had space for n paths on the OPEN list, what is the bound on the total cost of the solution that you can guarantee you will find? Again, your answer should be in terms of the parameters defined above. Explain your answer. (4 points total)

(3) Assume that you have a heuristic function $h(n)$ that is both monotone. For each evaluation function given below, will running A* with that evaluation function yield an optimal solution? If the answer is no, provide an upper bound for the ratio $\frac{\text{cost of returned solution}}{\text{cost of optimal solution}}$.

(3a) $f(n) = g(n) + h(n)$ (1 point total)

(3b) $f(n) = g(n) + 3 * h(n)$ (1 point total)

(3c) $f(n) = 3 * g(n) + h(n)$ (1 point total)

(4) Consider two monotone heuristics $h1$ and $h2$. $h1$ dominates $h2$, but $h1$ takes much longer to compute than $h2$.

(4a) Describe a situation in which you would recommend that Pacman use $h1$. (3 points total)

(4b) Describe a situation in which you would recommend that Pacman use $h2$. (3 points total)